WHAT IS CLAIMED IS:

S46 B1

1. An apparatus for compensating differential picture brightness of an optical image due to uneven illumination from an endoscope imaged onto a video camera comprising

a device for generating a compensating signal substantially representing at least one parameter of a compensating waveform required for the differential picture brightness of an optical image to produce a video signal representing an optical image having a substantially uniform brightness; and

a logic device operatively coupled to said compensating signal generating device and a video signal for adding the compensating signal and the video signal to produce an output video signal having its gain both vertically and horizontally compensated to represent an image having a substantially uniform brightness.

2. The apparatus of Claim 1 wherein said compensating signal device further includes

a device for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude; and

a device for generating a parabola waveform having a controlled amplitude and orientation.

3. The apparatus of Claim 2 wherein said logic device further includes

an adder operatively coupled to and adding said sawtooth waveform device, said parabolic waveform device and a video signal to produce a compensating signal which is applied to an adder together with a video signal used as an input to a video signal processor adjusting its gain both vertically and horizontally by increasing the gain of the video signal representing that part of the optical image which is less bright relative to a reference and reducing the gain of the video signal representing that part of the optical image which is brighter than a reference and wherein said video signal representing an optical image having a substantially uniform brightness.

4. A video signal compensator for compensating differential picture brightness of an optical image due to uneven illumination comprising

a device for generating a compensating signal substantially representing at least one parameter of a compensating waveform required for the differential picture brightness of an optical image to produce a video signal representing an optical image having a substantially uniform brightness; and

an adder operatively coupled to said compensating signal generating device and a video signal for adding the compensating signal and the video signal to produce an output video signal having its gain both vertically and horizontally compensated by increasing the gain of the video signal representing that part of the optical image which is less bright than a reference and

reducing the gain of the video signal representing that part of the optical image which is brighter than a reference compensating said video signal to represent an image having a substantially uniform brightness.

5. The video compensator of claim 4 wherein said differential picture brightness of an optical image is brighter at its center than at its periphery and wherein said adder adds said sawtooth waveform, said parabolic waveform and said video signal to produce a compensating signal as an input to a video signal processor to adjust its gain both vertically and horizontally by increasing the gain of the video signal in response the sawtooth waveform representing the periphery of the optical image and reducing the gain of the video signal in response to the parabolic waveform representing the center of the optical image resulting in said video signal representing an optical image having a substantially flat brightness.

6. The video compensator of claim 4 wherein said differential picture brightness of an optical image is brighter at its periphery than at its center and wherein said adder adds said sawtooth waveform, said parabolic waveform and said video signal to produce a compensating signal as an input to a video signal processor to adjust its gain both vertically and horizontally by decreasing the gain of the video signal in response the sawtooth waveform representing the periphery of the optical image and increasing the gain of the video signal in

response to the parabolic waveform representing the center of the optical image resulting in said video signal representing an optical image having a substantially flat brightness.

7. The video signal compensator of claim 4 wherein said compensating signal generating device is an analog signal generating device.

8. The video signal compensator of claim 4 wherein said compensating signal generating device is an digital signal generating device.

9. The video signal compensator of claim 7 wherein said analog signal generating device comprises

a sawtooth wave generator for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and controlled amplitude;

a parabola wave generator for generating a parabola waveform having a controlled amplitude and orientation; and

an analog signal adder operatively coupled to said sawtooth wave generator and said parabolic wave generator to add the sawtooth waveform and the parabolic waveform to produce a compensating signal.

10. The video signal compensator of claim 9 further comprising

a control device operatively coupled to said adder to increase the brightness of the compensating signal to a level

which is greater than the average of the differential brightness of the optical image due to the uneven illumination.

11. The video signal compensator of claim 8 wherein said digital signal generating device produces an analog compensating signal including illumination and color signals and wherein said digital signal generating device further includes

a digital storage device for receiving and storing a digital representation of the video signal having the differential brightness due to uneven illumination; and

a digital-to-analog converter operatively coupled to said digital storage device for producing an analog video signal representing the differential picture brightness of the optical image due to uneven illumination and applying the video signal to a first and second adder together with the analog compensating signal, wherein said first adder and second adder produce as an output compensated analog video signal which is applied to an analog video signal processor to produce a video signal having its gain both vertically and horizontally compensated by decreasing the gain of the video signal in response the sawtooth waveform representing the periphery of the optical image and increasing the gain of the video signal in response to the parabolic waveform representing the center of the optical image resulting in said video signal representing an optical image having a substantially flat brightness.

12. The video signal compensator of claim 8 wherein said digital signal generating device includes

a digital storage device for storing a digital representation of the video signal having the differential brightness due to uneven illumination; and

a programmable digital processor for digitally processing a digital representation of the video signal representing the differential picture brightness of the optical image due to uneven illumination to produce a digital compensating signal representing at least one parameter of a compensating waveform required to produce a video signal representing an optical image having a substantially uniform brightness and applying the digital compensating signal to said adder.

13. The video signal compensator of claim 12 wherein said programmable digital processor includes a pixel multiplexer/processor.

14. The video signal compensator of claim 8 wherein said digital signal generating device includes

a digital storage device for storing, for a predetermined period of time, a digital representation of the video signal having the differential brightness due to uneven illumination and applying said stored distal signal to an adder of adding the stored video signal with luminance and color compensating signal.

15. The video signal compensator of claim 8 wherein said digital signal generating device includes

a digital storage device for storing, for a predetermined time period, a digital representation of the video signal having the differential brightness due to uneven illumination and applying said stored digital signal to said pixel multiplexer/processor.

16. An apparatus for compensating differential picture brightness of an optical image due to uneven illumination from an endoscope imaged onto a video camera comprising

a device for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude;

a device for generating a parabola waveform having a controlled amplitude and orientation; and

a logic device operatively coupled to and adding said sawtooth waveform device, said parabolic waveform device and a video signal to produce a compensating signal which is applied to an adder together with a video signal used as an input to a video signal processor adjusting its gain both vertically and horizontally by increasing the gain of the video signal representing that part of the optical image which is less bright relative to a reference and reducing the gain of the video signal representing that part of the optical image which is brighter than a reference and wherein said video signal representing an optical image having a substantially uniform brightness.

17. The apparatus of claim 16 further comprising

a control device operatively coupled to said logic device to increase the brightness of the compensating signal to a level which is greater than the average of the differential brightness of the optical image due to the uneven illumination.

18. The Apparatus of claim 16 further including

a video driver amplifier operatively coupled to said logic device to apply the compensating signal to the video signal processor at a low impedance.

19. An apparatus for compensating for differential picture brightness of an optical image due to uneven illumination comprising

means for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude;

means for generating a parabola waveform having a controlled amplitude; and

an adder means operatively coupled to said sawtooth waveform device, said parabolic waveform device and a video signal for adding the sawtooth waveform, the parabolic waveform and the video signal to produce a compensating video signal used as an input to a video signal processor adjusting its gain both vertically and horizontally increasing the gain of the video signal representing that part of the optical image which is less bright than a reference and reducing the gain of the video signal

representing that part of the optical image which is brighter than a reference compensating said video signal to represent an optical image having substantially uniform brightness.

20. A video signal compensator for compensating for differential picture brightness of an optical image due to uneven illumination from an endoscope imaged onto a video sensor comprising

means for generating a compensating signal substantially representing at least one parameter of a compensating waveform required for the differential picture brightness of an optical image from the endoscope to produce a video signal representing an optical image having a substantially uniform brightness; and

adding means operatively coupled to said compensating signal generating means and a video signal for adding the compensating signal and the video signal to produce a compensating video signal which is applied to an input to video signal processor having its gain both vertically and horizontally compensated by increasing the gain of the video signal representing that part of the optical image from an endoscope which is less bright than a reference and reducing the gain of the video signal representing that part of the optical image from the endoscope which is brighter than a reference compensating said video signal to represent an optical image having a substantially uniform brightness.

21. The video signal compensator of claim 20 wherein said compensating signal generating means further comprising

a sawtooth wave generator for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and controlled amplitude;

a parabola wave generator for generating a parabola waveform having a controlled amplitude and orientation; and

an analog signal adder operatively coupled to said sawtooth wave generator and said parabolic wave generator to add the sawtooth waveform and the parabolic waveform to produce a compensating signal.

22 ~~21~~. The video signal compensator of claim 20 further comprising

a control device operatively coupled to said adding means to increase the brightness of the output video signal to a level which is greater than the average of the differential brightness of the optical image due to the uneven illumination.

23 ~~22~~. A device for compensating for differential picture brightness of an optical image brighter at its center than at its edges imaged onto a video camera comprising

a sawtooth wave generator for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude;

a parabola wave generator for generating a parabola waveform having a controlled amplitude and orientation;

an adder operatively coupled to said sawtooth wave generator, said parabolic wave generator and a video signal for adding said sawtooth waveform, said parabolic waveform and said video signal to produce a compensating video signal used as an input to a video signal processor for adjusting its gain both vertically and horizontally compensated by increasing the gain of the video signal in response the sawtooth waveform representing the periphery of the optical image and reducing the gain of the video signal in response to the parabolic waveform representing the center of the optical image compensating said video signal to represent an optical image having a substantially flat brightness.

23. A system comprising

an endoscope having a proximal end and a distal end;

a light guide located within the endoscope and extending from the proximal end to the distal end of the endoscope, said light guide having a light post at its proximal end which is adapted to receive light energy from a light source to transmit the light energy from its distal end to illuminate an operative site;

an optical image transferring member located with the endoscope and extending from the proximal end to the distal end of the endoscope;

a light source operatively connected to the light post to apply light energy to the light guide;

a video sensor operatively coupled to the distal end of the endoscope for imaging an optical image having differential picture brightness due to uneven illumination;

compensating apparatus operatively coupled to said video sensor comprising

a sawtooth wave generator for generating a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude;

a parabola wave generator for generating a parabola waveform having a controlled amplitude and orientation; and

an adder operatively coupled to said sawtooth wave generator, said parabolic wave generator and a video signal for adding said sawtooth waveform, said parabolic waveform and said video signal to produce a compensating video signal used as an input to video signal processor adjusting its gain both vertically and horizontally compensated by increasing the gain of the video signal representing that part of the optical image which is less bright than a reference and reducing the gain of the video signal representing that part of the optical image which is brighter than a reference compensating said video signal to represent an image having a substantially uniform brightness.

24. The system of claim 23 wherein said light guide is a fiber optic light guide and the differential picture brightness is brighter at its center than at its edges and wherein said compensating apparatus produces a compensating video signal used

as an input to a video signal processor adjusting its gain both vertically and horizontally compensated by increasing the gain of the video signal in response the sawtooth waveform representing the periphery of the optical image and reducing the gain of the video signal in response to the parabolic waveform representing the center of the optical image compensating said video signal to represent an optical image having a substantially flat brightness.

26. The system of claim 23 further comprising

an amplifier for amplifying the compensated video signal; and

a sensing device operatively coupled to the amplifier for receiving the compensated video signal and for sensing and removing noise therefrom.

27. A method for compensating for differential picture brightness of an optical image due to uneven illumination comprising the steps of

generating with a compensating signal device a compensating signal substantially representing at least one parameter of a compensating waveform required for the differential picture brightness of an optical image to produce a video signal representing an optical image having a substantially uniform brightness; and

adding with an adder operatively coupled to said compensating signal generating device and a video signal the

compensating signal and the video signal to produce an output compensating video signal having its gain both vertically and horizontally compensated by increasing the gain of the video signal representing that part of the optical image which is less bright than a reference and reducing the gain of the video signal representing that part of the optical image which is brighter than a reference compensating said video signal to represent an optical image having a substantially uniform brightness.

28 27. The method of claim 26 wherein said differential picture brightness of an optical image is brighter at its center than at its edges and wherein the step of adding produces a compensating signal used as an input to a video signal processor adjusting its gain both vertically and horizontally compensated by increasing the gain of the video signal in response the sawtooth waveform representing the edges of the optical image and reducing the gain of the video signal in response to the parabolic waveform representing the center of the optical image compensating said video signal to represent an optical image having a substantially flat brightness.

29 28. The method of claim 26 wherein said differential picture brightness of an optical image is brighter at its edges than at its center and wherein the step of adding produces a compensating signal used as an input to a video signal processor adjusting its gain both vertically and horizontally by decreasing the gain of the video signal in response the sawtooth

waveform representing the edges of the optical image and increasing the gain of the video signal in response to the parabolic waveform representing the edges of the optical image resulting in said video signal representing an optical image having a substantially flat brightness.

30 29. The method of claim 26 wherein the step of adding includes a compensating signal generating device which is an analog signal generating device for generating the compensating signal.

31 30. The method of claim 26 wherein the step of adding includes a compensating signal generating device which is an digital signal generating device for generating the compensating signal.

32 31. The method of claim 26 further including the step of increasing with a control device operatively coupled to said adder the brightness of the output video signal to a level which is greater than the average of the differential brightness of the optical image due to the uneven illumination.

33 32. The method of claim 26 further including the step of applying with a video driver amplifier operatively coupled to said adder the output video signal to a video camera through a low impedance.

~~33~~ 34. The method of claim 29 wherein said step of adding which includes a compensating signal generating device which is an analog signal generating device for generating the compensating signal further comprises the steps of

generating with a sawtooth wave generator a sawtooth waveform having a predetermined rising slope, a predetermined falling slope and a controlled amplitude;

generating with a parabola wave generator a parabola waveform having a controlled amplitude and orientation; and

adding with an analog signal adder the sawtooth waveform, the parabolic waveform and the video signal to produce a compensating signal.

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